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DIVISION OF POULTRY HUSBANDRY

Values of Various Protein Feeds for Growing Chicks

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

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This bulletin contains a report of six experiments which were conducted to learn more about the supplemental value of fish meal, meat and bone scraps, cottonseed meal, soybean oil meal, peanut meal, liver meal, and linseed meal in chick rations.

Neither mortality nor perosis (slipped tendon) was a factor in these experiments. The rations were not extreme enough to cause losses; they were also fortified by wheat gray shorts and the proper mineral balance, so perosis (slipped tendon) did not develop.

In all experiments, 6 per cent of vacuum-dried fish meal proved to be a valuable protein concentrate in chick rations. The gains in live weight were more rapid, and the gains were made with less feed than when the fish meal was not fed.

Soybean oil meal and cottonseed meal were about of equal value when fed with the other protein supplements used.

Liver meal gave poorer results than did vacuum-dried fish meal when fed in a ration along with soybean oil meal and cottonseed meal.

Neither peanut meal nor old process linseed oil meal gave as good results as soybean oil meal or cottonseed meal.

Dried whey, a rich source of vitamin G, produced more rapid gains in a ration containing no vacuum-dried fish meal, but did not cause more rapid gains with a ration containing 6 per cent of vacuum-dried fish meal. Both of these rations contained 5 per cent of choice dehydrated alfalfa leaf meal.

From 3.0 to 3.6 units of feed were required to produce a unit of gain in live weight. These figures are of value in helping a prospective producer in estimating the feed cost of growing chicks to ten or twelve weeks of age. Similar results should be secured from the better commercial feed mixtures and formulas given in this bulletin.

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VALUES OF VARIOUS PROTEIN FEEDS FOR GROWING CHICKS

R. M. Sherwood, Chief, and J. R. Couch, Poultry Husbandman, Division of Poultry Husbandry

Poultrymen and farmers are making many changes in their selections of enterprises for cash crops. A number have turned to the production of chickens. Many of these are carefully studying markets and expenses, including the costs of feed.

As a result of changes in farming, the amount and proportions of many feed crops are changing. Feed manufacturers are seeking more information on the value of the feeds available. They also want to know if the addition of some other feedstuff to their feed mixtures will improve them. It is with all of these problems in mind that this station conducted this series of experiments which are a continuation of the work reported in the Texas Agricultural Experiment Station Bulletin 569.

In the studies reported in Bulletin 569, sardine meal was used. In this study the product used was fish meal. The sardine meals and the fish meals used in the different studies were all vacuum-dried. The sardine meals were guaranteed to contain 67 per cent protein, and the fish meals were guaranteed to contain 64 per cent protein. The chemical analyses by the Division of Chemistry of the station showed that the sardine meals used in the first studies contained from 67 to 72.6 per cent protein and the fish meals reported in this publication contained from 67.5 to 67.8 per cent protein. The ash content of the fish meals reported in this study is very similar to that reported for the sardine meals in Bulletin 569.

A REVIEW OF LITERATURE

A rather comprehensive review of literature on the value of protein feeds for chicks and protein requirements of chicks has been given by Sherwood and Couch (12). The results of subsequent work are given in this publication. Smuts and co-workers (13, 14, 15) found that the protein of cottonseed meal has approximately 12½ per cent higher biological value than the protein of peanut meal. They report further that protein of peanut meal might be deficient in methionine, one of the amino acids and one which Rose (10) has shown to be essential. The studies of Smuts and co-workers and Rose were with rats used as the experimental animal. We have no information to show whether or not these findings will hold true with chicks.

Christiansen and co-workers (3) have found that for maximum efficiency the proteins of grains and soybean oil meal require other protein feeds as supplements.

Mussehl and Ackerson (7) and Ackerson and co-workers (1) reported that cottonseed meal produced more rapid gains, greater gains per unit of feed consumed, and better retention of nitrogen, calcium, and phosphorus than linseed oil meal. They also reported that neither of the above feeds was equal to dried butter milk or soybean oil meal when used in the rations studied by them.

Sherwood and Couch (11) found that rations containing sardine meal, meat and bone scraps or dried skimmed milk were more satisfactory than rations that did not contain these protein feeds. They reported that cottonseed meal and soybean oil meal may be used interchangeably in chick rations containing as much as 6 per cent of the protein feeds mentioned above.

METHODS OF PROCEDURE

The chicks used in experiments 91 and 92 were White Leghorns of similar breeding. They were fed in batteries for ten weeks from hatching time. Fifty-two chicks were fed each ration in each of these experiments. The chicks used in the other experiments reported in this bulletin were New Hampshires of like breeding, also fed ten weeks. Fifty chicks were fed each ration in experiments 95, 105, and 113, and fifty-two chicks were fed each ration in experiment 101. All chicks were weighed individually at the beginning and close of the experiments and at two week intervals during the experiments. All groups were rotated in the batteries every two weeks during the experimental period. Therefore, no group occupied the same relative position in the batteries or building for more than two weeks. Lights were so supplied that the chicks had a fourteen-hour feeding period daily. Feed and tap water were before the chicks at all times.

At least three feeds rich in protein were used in each ration. Substitution of one protein feed for another, either as a whole or in part, is made where any one of these feeds is used with at least two other protein feeds. It is thus the supplemental value of one high protein feed with another that is studied in these experiments rather than the value of these feeds as the chief source of protein.

Samples of all feeds were analyzed by the Division of Chemistry. Table 1 gives the analysis of the feeds. The percentage of the different feeds used in the different rations of the various experiments and the calculated chemical analyses of different rations are given in Tables 2 to 7. The percentage of protein ranged from 18.38 to 20.09. These differences in the percentages of protein in the different rations are not wide and were due largely to the substitution, pound for pound, of protein feeds containing different amounts of protein. Unpublished data at this station secured at the time these experiments were being conducted with rations similar to those used in these experiments showed that 18 per cent of protein was adequate. Therefore, differences found by the substitution of the protein feeds studied

Table 1. Percentage composition of feeds

Feeds	Feed identification number	Protein	Fat	Crude fibre	Nitrogen-free extract	Water	Ash	Calcium	Phosphorus
		%	%	%	%	%	%	%	%
Dried whey	587	11.74	0.82	0.40	70.49	7.17	9.38	0.81	0.71
65% Protein fish meal	588	67.48	3.53	0.27	6.33	8.35	14.04	4.37	2.55
65% Protein fish meal	596	67.84	5.50	0.52	5.61	5.96	14.57	4.50	2.74
50% Protein meat and bone scraps	579	51.11	9.70	1.87	1.40	4.29	31.63	10.92	5.27
43% Protein cottonseed meal	583	44.63	6.95	10.21	25.87	6.48	5.86	0.17	1.10
43% Protein cottonseed meal	667	44.02	7.13	9.42	27.17	6.34	5.92	0.17	1.10
41% Protein soybean oil meal	469	42.94	4.48	6.33	30.60	9.39	6.26	0.34	0.73
41% Protein soybean oil meal	615	43.80	4.34	5.49	27.63	12.23	6.51	0.28	0.58
43% Protein peanut meal	597	41.91	8.35	11.91	27.66	5.43	4.74	0.21	0.40
34% Protein linseed meal	613	37.10	5.03	8.18	34.42	9.72	5.55	0.44	0.88
63.6% Protein liver meal	635	63.60	18.71	0.95	4.30	7.73	4.71	0.19	0.89
Wheat gray shorts	575	17.85	4.53	5.76	57.39	10.55	3.92	0.14	0.86
Wheat gray shorts	600	17.30	4.43	6.66	56.49	10.73	4.39	0.16	0.74
Wheat gray shorts	663	18.99	4.55	6.81	54.06	10.50	5.09	0.16	0.97
Raw bone meal	449	27.91	3.84	0.65	2.44	6.67	58.49	22.37	10.43
Raw bone meal	578	25.41	3.65	0.48	1.66	5.00	63.80	24.21	10.36
Chick size oyster shell	227	.....	.....	.....	.....	.....	.....	38.66	0.02
Chick size oyster shell	616	.....	.....	.....	.....	.....	.....	37.54	.....
Ground whole oats	577	10.44	5.57	11.50	59.68	9.39	3.42	0.11	0.34
Ground whole oats	601	9.61	5.40	12.96	59.23	8.69	4.11	0.16	0.29
Ground whole oats	664	11.06	5.36	10.31	61.48	8.47	3.32	0.11	0.31
Ground milo	589	11.46	3.16	2.46	70.77	10.55	1.60	0.03	0.27
Ground milo	638	11.35	3.23	1.91	71.76	10.03	1.72	0.07	0.23
Ground yellow corn	574	9.58	4.51	2.39	72.33	9.94	1.25	0.04	0.24
Ground yellow corn	581	9.45	4.48	2.37	72.01	10.32	1.37	0.06	0.27
Dehydrated alfalfa leaf meal	582	22.02	3.00	16.29	40.15	6.82	11.72	1.37	0.30
Dehydrated alfalfa leaf meal	584	23.24	3.30	16.97	42.66	2.83	11.00	1.29	0.27
Dehydrated alfalfa leaf meal	662	22.77	3.19	20.69	36.66	5.16	11.53	1.77	0.31

Table 2. Percentage of ingredients and calculated chemical analysis of rations fed in Experiment 91

Feed	Feed Identification number*	Percentage ingredients of rations				
		Ration 1	Ration 2	Ration 3	Ration 4	Ration 5
65% Protein fish meal	596	6	6	3	6	.....
50% Protein meat and bone scraps	579	6	6	3	.....	6
43% Protein cottonseed meal	583	.....	6	6	6	6
41% Protein soybean oil meal	469	6	.....	6	6	6
Raw bone meal	449	0.40	.....	2	2.50	1.10
Chick size oyster shell	227	1.50	1.75	1.65	1.75	1.75
Salt	.....	0.5	0.5	0.5	0.5	0.5
Wheat gray shorts	575	20	20	20	20	20
Ground whole oats	577	5	5	5	5	5
Dehydrated alfalfa leaf meal	582	5	5	5	5	5
Fortified cod liver oil	.....	0.25	0.25	0.25	0.25	0.25
Ground yellow corn	574	49.35	49.50	47.60	47.00	48.40

Nutrient	Calculated chemical analysis of rations				
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5
	%	%	%	%	%
Protein	19.75	19.75	19.14	19.72	18.47
Fat	4.77	4.90	4.72	4.58	4.83
Crude fiber	4.24	4.47	4.76	4.70	4.81
Nitrogen-free extract	54.43	54.24	54.55	54.26	54.98
Water	9.04	8.85	9.04	9.07	9.01
Ash	5.54	5.28	5.43	5.19	5.42
Calcium	1.75	1.75	1.72	1.67	1.75
Phosphorus	0.89	0.88	0.88	0.85	0.87

*For analysis of these feeds, see Table 1.

Table 3. Percentage of ingredients and calculated chemical analysis of rations fed in Experiment 92

Feed	Feed Identification number*	Percentage ingredients of rations				
		Ration 1	Ration 2	Ration 3	Ration 4	Ration 5
65% Protein fish meal	596	6	6	3	6	.....
50% Protein meat and bone scraps	579	6	6	3	.....	6
41% Protein soybean oil meal	469	6	.....	6	6	6
43% Protein cottonseed meal	583	.....	6	6	6	6
Raw bone meal	449	0.40	.....	2	2.50	1.10
Chick size oyster shell	227	1.50	1.75	1.65	1.75	1.75
Salt	.....	0.5	0.5	0.5	0.5	0.5
Wheat gray shorts	575	20	20	20	20	20
Ground whole oats	577	5	5	5	5	5
Dehydrated alfalfa leaf meal	584	5	5	5	5	5
Fortified cod liver oil	.....	0.25	0.25	0.25	0.25	0.25
Ground yellow corn	574	49.35	49.50	47.60	47.00	48.40

Nutrient	Calculated chemical analysis of rations				
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5
	%	%	%	%	%
Protein	19.81	19.81	19.20	19.78	18.53
Fat	4.79	4.92	4.74	4.60	4.85
Crude fiber	4.28	4.51	4.80	4.74	4.85
Nitrogen-free extract	54.55	54.36	54.67	54.38	55.10
Water	8.84	8.65	8.84	8.87	8.81
Ash	5.50	5.24	5.39	5.15	5.38
Calcium	1.74	1.74	1.71	1.66	1.74
Phosphorus	0.88	0.87	0.87	0.84	0.86

*For analysis of these feeds, see Table 1.

Table 4. Percentage of ingredients and calculated chemical analysis of rations fed in Experiment 101

Feeds	Feed* identification number	Percentage ingredients of rations					
		Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
65% Protein fish meal	588	6	6	6	.....	.....	.....
50% Protein meat and bone scraps	579	.....	.....	.....	6	6	6
43% Protein cottonseed meal	583	6	6	.....	6	6	.....
41% Protein soybean oil meal	469	6	.....	6	6	.....	6
43% Protein peanut meal	597	.....	6	6	.....	6	6
Chick size oyster shell	227	2	2	2	2	2	2
Raw bone meal	449	1	1	1	.....	.....	.....
Wheat gray shorts	600	20	20	20	20	20	20
Ground whole oats	601	10	10	10	10	10	10
Salt	.....	0.5	0.5	0.5	0.5	0.5	0.5
Dehydrated alfalfa leaf meal	584	5	5	5	5	5	5
Ground milo	589	20	20	20	20	20	20
Ground yellow corn	581	23.375	23.375	23.375	24.375	24.375	24.375
Fortified cod liver oil	.....	0.125	0.125	0.125	0.125	0.125	0.125

Nutrient	Calculated chemical analysis of rations					
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
	%	%	%	%	%	%
Protein	19.67	19.60	19.50	18.50	18.43	18.33
Fat	4.22	4.45	4.30	4.59	4.82	4.67
Crude fiber	5.54	5.87	5.64	5.65	5.98	5.75
Nitrogen-free extract	54.12	53.94	54.23	54.52	54.34	54.63
Water	9.20	8.97	9.14	9.00	8.77	8.94
Ash	4.63	4.53	4.56	5.12	5.02	5.05
Calcium	1.41	1.40	1.41	1.59	1.58	1.59
Phosphorus	0.66	0.64	0.61	0.74	0.72	0.69

*For analysis of these feeds, see Table 1.

Table 5. Percentage of ingredients and calculated chemical analysis of rations fed in Experiment 113

Feeds	Feed* identification number	Percentage ingredients of rations					
		Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
65% Protein fish meal	588	6	.....	6	6	6	6
63.6% Protein liver meal	635	.....	6	.....	.....	.....	.....
43% Protein cottonseed meal	667	6	6	6	6	4	2
41% Protein soybean oil meal	615	6	6	4	2	6	6
34% Protein linseed meal	613	.....	.....	2	4	2	4
Raw bone meal	578	1	1	1	1	1	1
Chick size oyster shell	616	2	2	2	2	2	2
Dehydrated alfalfa leaf meal	662	5	5	5	5	5	5
Ground milo	638	20	20	20	20	20	20
Ground whole oats	664	10	10	10	10	10	10
Wheat gray shorts	663	20	20	20	20	20	20
Salt	.....	0.5	0.5	0.5	0.5	0.5	0.5
Fortified cod liver oil	.....	0.25	0.25	0.25	0.25	0.25	0.25
Ground yellow corn	581	23.25	23.25	23.25	23.25	23.25	23.25

Table 5. Percentage of ingredients and calculated chemical analysis of rations fed in Experiment 113—Continued

Nutrient	Calculated chemical analysis of rations					
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
	%	%	%	%	%	%
Protein	20.09	19.86	19.95	19.82	19.95	19.81
Fat	4.24	5.15	4.25	4.27	4.20	4.15
Crude fiber	5.28	5.32	5.33	5.39	5.25	5.23
Nitrogen-free extract	53.57	53.45	53.71	53.84	53.72	53.86
Water	9.28	9.24	9.23	9.18	9.34	9.42
Ash	4.82	4.26	4.80	4.78	4.81	4.80
Calcium	1.43	1.18	1.43	1.44	1.44	1.44
Phosphorus	0.70	0.60	0.71	0.72	0.69	0.69

*For analysis of these feeds, see Table 1.

Table 6. Percentage of ingredients and calculated chemical analysis of rations fed in Experiment 95

Feeds	Feed* identification number	Percentage ingredients of rations					
		Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
65% Protein fish meal	588	6	6	6	6	6	6
43% Protein cottonseed meal	583	6	6	6	6	6	6
41% Protein soybean oil meal	469	6	6	6	6	6	6
Raw bone meal	449	1.25	1.25	1.25	1.25	1.25	1.25
Chick size oyster shell	227	2.50	2.50	2.50	2.50	2.50	2.50
Salt	.....	0.50	0.50	0.50	0.50	0.50	0.50
Wheat gray shorts	575	20	20	20	20	20	20
Ground whole oats	577	5	5	5	5	5	5
Dehydrated alfalfa leaf meal	584	5	5	5	5	5	5
Fortified cod liver oil	.....	0.125	0.125	0.125	0.125	0.125	0.125
Ground yellow corn	581	47.625	46.625	45.625	44.625	43.625	42.625
Dried whey	587	0	1	2	3	4	5

Nutrient	Calculated chemical analysis of rations					
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
	%	%	%	%	%	%
Protein	19.41	19.44	19.45	19.48	19.50	19.53
Fat	4.44	4.41	4.37	4.33	4.29	4.26
Crude fiber	4.73	4.71	4.69	4.67	4.65	4.63
Nitrogen-free extract	54.68	54.66	54.65	54.63	54.62	54.60
Water	9.16	9.13	9.10	9.08	9.04	9.01
Ash	4.45	4.53	4.62	4.69	4.78	4.85
Calcium	1.67	1.67	1.69	1.69	1.70	1.71
Phosphorus	0.72	0.73	0.72	0.73	0.74	0.75

*For analysis of these feeds, see Table 1.

Table 7. Percentage of ingredients and calculated chemical analysis of rations fed in Experiment 105

Feeds	Feed* identification number	Percentage ingredients of rations					
		Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
50% Protein meat and bone scraps	579	6	6	6	6	6	6
43% Protein cottonseed meal	583	6	6	6	6	6	6
41% Protein soybean oil meal	615	6	6	6	6	6	6
Salt	.....	0.5	0.5	0.5	0.5	0.5	0.5
Chick size oyster shell	227	1.5	1.5	1.5	1.5	1.5	1.5
Raw bone meal	449	1	1	1	1	1	1
Ground whole oats	601	10	10	10	10	10	10
Wheat gray shorts	600	20	20	20	20	20	20
Ground milo	589	20	20	20	20	20	20
Dehydrated alfalfa leaf meal	584	5	5	5	5	5	5
Fortified cod liver oil	.....	0.125	0.125	0.125	0.125	0.125	0.125
Ground yellow corn	581	23.875	22.875	21.875	20.875	19.875	18.875
Dried whey	.....	0	1	2	3	4	5

Nutrient	Calculated chemical analysis of rations					
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
	%	%	%	%	%	%
Protein	18.79	18.81	18.83	18.85	18.88	18.90
Fat	4.60	4.56	4.53	4.49	4.45	4.42
Crude fiber	5.60	5.57	5.56	5.53	5.52	5.50
Nitrogen-free extract	54.00	53.98	53.97	53.95	53.94	53.92
Water	9.18	9.15	9.12	9.09	9.06	9.03
Ash	5.71	5.78	5.87	5.95	6.03	6.11
Calcium	1.62	1.62	1.64	1.64	1.65	1.66
Phosphorus	0.82	0.83	0.83	0.84	0.84	0.85

*For analysis of these feeds, see Table 1.

is not thought to be caused by the differences in the total amount of protein present, but by the quality of the protein or by other factors not accounted for.

The calcium and phosphorus content of the rations in each experiment varied only slightly, and the calcium-phosphorus ratio was practically constant in the different rations of the experiments.

The average gain in live weight of both cockerels and pullets, the amount of feed required to produce a unit of gain in live weight, and the per cent mortality were used as criteria in judging the efficiency of a protein supplement. When a feed is said to be better or superior, these criteria are considered. The only experiment in which the mortality was high enough to be considered was experiment 101, Table 9. Here there may be an indication that fish meal is slightly more satisfactory than meat and bone scraps. This difference was not noted by Sherwood and Couch (12) in their previous publication on a similar subject. In fact, the feeding of meat and bone scraps resulted in slightly lower losses than sardine meal in their previous work.

Table 8. Experiments 91 and 92. A comparison of the effect of various amounts of protein concentrates on the gains in live weight, feed efficiency, and mortality in chick rations

	Protein concentrates and percentages used in each ration				
	Ration 1 6% Fish meal, 6% Meat and bone scraps, 6% Soybean oil meal	Ration 2 6% Fish meal, 6% Meat and bone scraps, 6% Cotton-seed meal	Ration 3 3% Fish meal, 3% Meat and bone scraps, 6% Soybean oil meal, 6% Cotton-seed meal	Ration 4 6% Fish meal, 6% Soybean oil meal, 6% Cotton-seed meal	Ration 5 6% Meat and bone scraps, 6% Soybean oil meal, 6% Cotton-seed meal
	Average gain in live weight in grams				
Cockerels					
Experiment 91	899.0	915.0	875.9	890.7	804.2
Experiment 92	851.2	864.7	847.2	908.5	798.1
Experiments 91 and 92	874.7	889.9	860.7	900.6	801.2
Pullets					
Experiment 91	722.4	735.5	722.0	750.7	672.5
Experiment 92	687.4	680.4	672.7	731.0	684.7
Experiments 91 and 92	705.6	709.0	699.4	741.9	678.6
	Grams of feed required to produce one gram of gain				
Experiment 91	3.41	3.22	3.35	3.43	3.57
Experiment 92	3.29	3.41	3.33	3.12	3.58
Experiments 91 and 92	3.35	3.31	3.34	3.28	3.58
	Percentage of chicks that died during the experiment				
Experiment 91	0.0	1.96	0.0	0.0	0.0
Experiment 92	0.0	2.04	0.0	0.0	0.0
Experiments 91 and 92	0.0	2.00	0.0	0.0	0.0

Table 9. Experiment 101. A comparison of various protein concentrates on gains in live weight, feed efficiency, and mortality in chick rations

	Protein concentrates and percentages used in each ration					
	Ration 1 6% Fish meal, 6% Cottonseed meal, 6% Soybean oil meal	Ration 2 6% Fish meal, 6% Cottonseed meal, 6% Peanut meal	Ration 3 6% Fish meal, 6% Soybean oil meal, 6% Peanut meal	Ration 4 6% Meat and bone scraps, 6% Cottonseed meal, 6% Soybean oil meal	Ration 5 6% Meat and bond scraps, 6% Cottonseed meal, 6% Peanut meal	Ration 6 6% Meat and bone scraps, 6% Soybean oil meal, 6% Peanut meal
	Average gain in live weight in grams					
Cockerels	990.0	898.8	888.1	765.2	676.7	766.6
Pullets	775.2	778.9	719.7	633.8	572.8	558.6
	Grams of feed required to produce one gram of gain					
Cockerels and pullets	3.20	3.20	3.20	3.53	3.64	3.60
	Percentage of chicks that died during the experiment					
Cockerels and pullets	0.0	6.12	0.0	4.08	6.52	7.84

EXPERIMENTAL RESULTS

Fish Meal as a Substitute for Other Protein Feeds

The fish meal used in this series of experiments was a vacuum-dried product which has been found to be of a higher biological value and contains more vitamin A and vitamin G than meals cooked and dried at high temperatures.

In this series of experiments, fish meal was a better protein supplement along with soybean oil meal and cottonseed meal than meat and bone scraps as shown in Table 8, rations 4 and 5. In Table 9, rations 1 and 4, the same results are shown. Fish meal was also superior to meat and bone scraps when used as a supplement along with peanut meal and cottonseed meal or soybean oil meal. These figures are shown in Table 9, rations 2 and 5 and rations 3 and 6. In all cases with these combinations of feeds studied, the gains in live weight were higher and the units of feed required to produce a unit of gain in live weight was lower when the fish meal was fed than when the beat and bone scraps was fed.

It is also noted in Table 8, ration 3, that the substitution of 3 pounds of meat and bone scraps for 3 pounds of fish meal in ration 4 gave gains about midway between those produced by ration 4 which contained fish meal and ration 5 which contained meat and bone scraps. The units of feed required to produce a unit of gain in live weight for ration 3 was less than for ration 5 and more than for ration 4. These results for fish meal are in line with those reported by Sherwood and Couch (12) in a previous publication using sardine meal.

A comparison of ration 1 with ration 5, Table 8, shows that chicks fed fish meal along with meat and bone scraps and soybean oil meal gained faster and made gains with less feed than when cottonseed meal was used along with meat and bone scraps and soybean oil meal.

Fish meal, when fed with meat and bone scraps and cottonseed meal, also produced greater gains with less feed than did soybean oil meal when fed with meat and bone scraps and cottonseed meal. These figures are shown in Table 8, rations 2 and 5.

Liver Meal as a Protein Feed

In one experiment, liver meal was compared with fish meal as a supplement along with soybean oil meal and cottonseed meal. It is shown in Table 10, rations 1 and 2, that the gains were less for the liver meal and feed required per unit of gain was more than for fish meal.

Meat and Bone Scraps as Compared with Cottonseed Meal and Soybean Oil Meal

Cottonseed meal, soybean oil meal, and fish meal gave as good or slightly better results than meat and bone scraps, soybean oil meal, and fish meal. These results are shown in Table 8, rations 1 and 4.

Table 10. Experiment 113. A comparison of the effect of various amounts of protein concentrates on the gains in live weight, feed effieciency and mortality in chick rations

	Protein concentrates and percentages used in each ration					
	Ration 1 6% Fish meal, 6% Cotton-seed meal, 6% Soybean oil meal	Ration 2 6% Liver meal, 6% Cotton-seed meal, 6% Soybean oil meal	Ration 3 6% Fish meal, 6% Cotton-seed meal, 4% Soybean oil meal, 2% Linseed meal	Ration 4 6% Fish meal, 6% Cotton-seed meal, 2% Soybean oil meal, 4% Linseed meal	Ration 5 6% Fish meal, 4% Cotton-seed meal, 6% Soybean oil meal, 2% Linseed meal	Ration 6 6% Fish meal, 2% Cotton-seed meal, 6% Soybean oil meal, 4% Linseed meal
	Average gain in live weight in grams					
Cockerels	955.9	838.5	930.8	908.7	929.9	924.3
Pullets	774.2	755.9	741.4	739.1	774.9	766.7
	Grams of feed required to produce one gram of gain					
Cockerels and pullets	3.00	3.16	2.99	3.29	3.18	3.10
	Percentage of chicks that died during the experiment					
Cockerels and pullets	2.13	0.0	0.0	0.0	0.0	0.0

Soybean oil meal, cottonseed meal, and fish meal gave as good or slightly better results than meat and bone scraps, fish meal, and cottonseed meal. These results are shown in Table 8, rations 2 and 4.

Peanut Meal as Compared with Cottonseed Meal and Soybean Oil Meal

In these experiments, the chicks receiving the cottonseed meal, soybean oil meal, and fish meal or meat and bone scraps made more rapid gains than those fed peanut meal, soybean oil meal, and fish meal or meat and bone scraps. It required about the same amount of feed to produce the gains on the different combinations of feed. These results are shown in Table 9, rations 1 and 3, and Table 9, rations 4 and 6.

Soybean oil meal, cottonseed meal, and meat and bone scraps or fish meal produced somewhat greater gains with chicks than did peanut meal with cottonseed meal and bone scraps or fish meal. Only a slight difference was shown in feed required for these gains. The results are shown in Table 9, rations 1 and 2, and in Table 9, rations 4 and 5.

Soybean Oil Meal and Cottonseed Meal as Supplements for Chicks

The data in Table 8, rations 1 and 2, show that there is no significant difference between soybean oil meal and cottonseed meal as protein feeds for chicks when fed along with meat and bone scraps and fish meal.

When fed with fish meal and peanut meal, Table 9, rations 2 and 3, the results are also about the same. There is a slight difference favoring the cottonseed meal over the soybean oil meal.

When meat and bone scraps and peanut meal are used, the cockerels made better gains and the pullets slightly poorer gains with soybean oil meal as compared with the cottonseed meal. These results are shown in Table 9, rations 5 and 6.

Linseed Oil Meal as a Partial Substitute for Soybean Oil Meal or Cottonseed Meal

The data given in Table 10, rations 3 and 4, as compared with ration 1 show that with rations containing fish meal, soybean oil meal, and cottonseed meal the gains were lower when either 2 and 4 per cent of linseed oil meal was used as a substitute for a like amount of soybean oil meal. In the same table, Table 10, rations 5 and 6 as compared with ration 1, it was apparent that there was no advantage gained by substituting 2 or 4 pounds of old process linseed oil meal for 2 or 4 pounds of cottonseed meal when fed in rations containing fish meal and soybean oil meal. In fact, with cockerels, there was a slightly lower gain with 2 or 4 per cent linseed oil meal substituted for a like amount of cottonseed meal. The feed required for a unit of gain in live weight was higher with the linseed oil meal than with the cottonseed meal. These results are in line with results of Mussehl and Ackerson (7) and Ackerson and co-workers (1).

Adequacy of the Control Rations in Meeting the Vitamin G Requirements of Chicks

Norris and co-workers (8) stated that chicks need approximately 290 units of vitamin G per 100 grams of feed in order to attain normal weight at eight weeks of age. In a later study, Heuser, Wilgus, and Norris (5) reported that the ration should contain approximately 350, 290, 240, 200, 160, 130, and 100 units of vitamin G per 100 grams of feed for normal growth and feed consumption for chicks from 2 to 8 weeks of age, respectively.

In the studies reported in this bulletin, rations containing 6 per cent of either fish meal or meat and bone scraps were used as control rations. These rations (ration 1, Tables 6 and 7) have given good results at the Texas Station for the feeding of growing chickens from hatching time until they are ten to twelve weeks of age (11). It seemed advisable, however, to check the adequacy of these rations to see whether they meet the vitamin G requirements of chicks.

Two experiments were conducted. In the first one, a basal ration containing 6 per cent of fish meal (ration 1, Table 6) was fed together with similar rations (Table 6, rations 2 to 6) containing 1, 2, 3, 4, and 5 per cent of dried whey, a feed which is widely used by feed manufacturers and poultrymen as a carrier of vitamin G. The vitamin G content of rations 1 to 6, Table 6, is approximately 280, 310, 340, 360, 400, and 430 units of vitamin G per 100 grams of ration, respectively, as calculated from the values given by Norris and co-workers (8) for the vitamin G content of all feeds except cottonseed meal and from that given by Levine and Remington (6) for the vitamin G content of cottonseed meal. The latter workers report their results as Borquin-Sherman units of vitamin G or flavin per gram. Norris and co-workers (8) reported their results in chick units, and they state that a chick unit is appoximately equal to a microgram of flavin. A conversion factor of three is used in converting the Borquin-Sherman flavin units to Norris chick units, according to the work of Booher (2).

There was no increase in gains of live weight of the chicks or reduction of units of feed required to produce a unit of gain when 1 to 5 per cent of dried whey was used with fish meal, Table 11, rations 1 to 6. The small mortality noted in the experiment is not thought to be related to the feed. The calculated vitamin G content of the basal ration used in this experiment is slightly lower than that reported by Norris et al. (8), and also by Heuser and co-workers (5) for the first three weeks of the chick's life. After three weeks, the vitamin G contained in the basal ration of this experiment is considerably higher than that reported by the latter workers to be adequate for normal growth and food consumption.

In a study conducted by Sherwood and Couch (11), it was observed that a ration similar to the basal ration used in these studies failed to sup-

Table 11. Experiment 95. The effect of the addition of varying amounts of dried whey to a ration in which 6% Fish Meal, 6% Cottonseed Meal, and 6% Soybean Oil Meal constitute the protein concentrate components of the ration

	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
	Percentage of dried whey used in each ration					
	0	1	2	3	4	5
	Average gain in live weight in grams					
Cockerels	1218.7	1065.0	1110.3	1096.2	1061.8	1121.0
Pullets	918.0	873.2	899.6	906.1	896.5	888.6
	Grams of feed required to produce one gram of gain					
Cockerels and Pullets	2.99	3.23	3.15	3.11	3.31	3.24
	Percentage of chicks that died during the experiment					
Cockerels and Pullets	4.35	0.0	0.0	0.0	0.0	2.27

port growth when the dehydrated alfalfa leaf meal was reduced to approximately 1 per cent. It is well known that dehydrated alfalfa leaf meal is a potent source of vitamin G.

In the second experiment, 6 pounds of meat and bone scraps were used in the place of the 6 pounds of fish meal used in the first experiment. Table 7, ration 1, is the basal ration for this experiment, and Table 7, rations 2 to 6, are those containing 1, 2, 3, 4, and 5 per cent dried whey. The flavin content of the rations in Table 7 range is approximately 270, 300, 330, 360, 390, and 420 units of vitamin G per 100 grams of feed.

Table 12. Experiment 105. The effect of the addition of varying amounts of dried whey to a ration in which 6% Meat and Bone Scraps, 6% Cottonseed Meal, and 6% Soybean Oil Meal constitute the protein concentrate components of the ration

	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5	Ration 6
	Percentage of dried whey in each ration					
	0	1	2	3	4	5
	Average gain in live weight in grams					
Cockerels	753.8	821.9	857.5	805.7	759.4	834.2
Pullets	662.8	724.3	714.8	675.1	658.4	716.3
	Grams of feed required to produce one gram of gain					
Cockerels and Pullets	3.31	3.30	3.23	3.15	3.49	3.23
	Percentage of chicks that died during the experiment					
Cockerels and Pullets	0.0	6.12	0.0	1.96	0.0	4.08

The addition of 1 per cent of dried whey produced an increase in the gains in live weight of the chicks without any effect upon the units of feed required to produce a unit of gain. The small mortality noted in this experiment was not thought to be related to the feed. The data presented above show no evidence that the differences in the gains made with the rations containing fish meal or meat and bone scraps are related to the vitamin G content.

CONCLUSIONS

The data presented in this bulletin indicate that under the conditions of these experiments the following conclusions are warranted:

1. Vacuum-dried fish meal gave the best results of any of the protein feeds studied when used as a supplement to any two other protein feeds used in the study. The chicks grew more rapidly and produced gains with a smaller amount of feed when the fish meal was fed than when it was not fed.
2. Liver meal did not prove to be a satisfactory substitute for vacuum-dried fish meal.
3. When vacuum-dried fish meal is used to make up 6 per cent of the chick ration the remaining 12 per cent of the protein concentrates may be made up of meat and bone scraps, soybean oil meal, or cottonseed meal using 6 per cent of each feed.
4. Peanut meal was not a good substitute for cottonseed meal or soybean oil meal in the chick rations studied.
5. Old process linseed oil meal, when used as a partial substitute for soybean oil meal or cottonseed meal, produced poorer gains and the amount required to produce a unit of gain in live weight was higher than when the linseed oil meal was not used.
6. Rations containing 6 per cent of vacuum-dried fish meal and 5 per cent of choice dehydrated alfalfa leaf meal were not improved by the addition of vitamin G supplied by dried whey.
7. The use of a ration containing 1 per cent of dried whey and 6 per cent meat and bone scraps, 6 per cent cottonseed meal, 6 per cent soybean oil meal, and 5 per cent choice dehydrated alfalfa leaf meal resulted in greater gains than did the same ration not containing dried whey.

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